Transformer Bushing Monitoring System

Installation Manual





ZTZ Services International, Inc.
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1.0 INTRODUCTION

The ZVCM Bushing Monitoring System is designed to simultaneously monitor two, three phase groups of bushings, free standing CT's, and CCVT using analysis of the bushing leakage current.

The device incorporates three different measurement modes on each tested component to provide accurate Power Factor and Capacitance values to evaluate the condition of insulation.

The measurement modes are:

- Phase Comparison – compares the power factor of tested component with another tested component energized with the same phase voltage.
- Sum-of-Three Current test – measures the imbalance current from the summation of A, B, and C phase currents from three tested components such as the three HV or LV bushings on the transformer.
- Adjacent Phase Reference test – compares the power factor of the tested components with other phase components on the same equipment.
- High-to-Low test – compares special attributes of the HV bushing to LV bushing
- Reference test – compares special attributes of the bushing to an associated PT or CCVT.

The bushing sensors/adapters are connected to the capacitor taps designed for all types of bushings to allow measurement of the leakage current up to 140 mA. The adapters are designed for bushings with grounded and undergrounded capacitor taps. The adapter is designed to prevent a voltage developing on the equipment should the sensor become disconnected from ZVCM.

The standard data output is provided via RS-485 using Modbus or DNP3.0 protocol.

Alarm relay output contacts rated 8A @ 125VAC.

Power Supply: 90~264 VAC, 47~63 Hz.

Surge withstand: ANSI/IEEE C 37.90.1~1989

Ambient operating temperature: -40 C to 65 C.

Storage temperature: -40 C to 85 C.

Physical dimensions:

21.5" X 16.5" X 6.0" Stainless Steel (3 and 6 channels)

24.0" X 24.0" X 8.0" Stainless Steel (9 and 12 channels)

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ZVCM Technical Specifications

Measured Data	Range	Resolution	Accuracy	
Power Factor	0-100%	0.01%	±0.045% abs	Power Comparison Mode
Current	0-140 mA	0.1 mA	1.5% of reading	
Capacitance	100 – 5000 pF	0.1 pF	1.0% of reading	Phase Comparison Mode
Imbalance Current Phase Angle	0-360 degree	0.1 degree	1.0% of reading	
ADC		16 bit		
Sampling Rate for 6 channel simultaneously sampling		10 kHz		

Bushing Sensor Specifications

Rated Transformer Voltage	Any Voltage
Type of Capacitor Tap	Any Manufacturer
Operating Temperature Range	-55C to +90C, 95% RH (non condensing)
Installation Environment	Ourdoor, no corrosive agents in the air
Maximum Permitted Power Frequency Current Through Bushing Insulation	140 mA, rms
Maximum 60 Hz Voltage at the Test Tap	2.5 kV
Maximum possible 60 Hz Voltage at Test Tap due to Opened or Mistakenly cut coax cable	120 Volts

2.0 PRODUCT DESCRIPTION

The following section describes the connection layout to the ZVCM Enclosure and parts included. The Bushing Monitoring System (ZVCM) includes:

- ZVCM Enclosure
- Bushing sensors
- Software
- Communication cable

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View of IP56 Stainless Steel Enclosure and six bushing sensors with 50 foot RG58 leads.

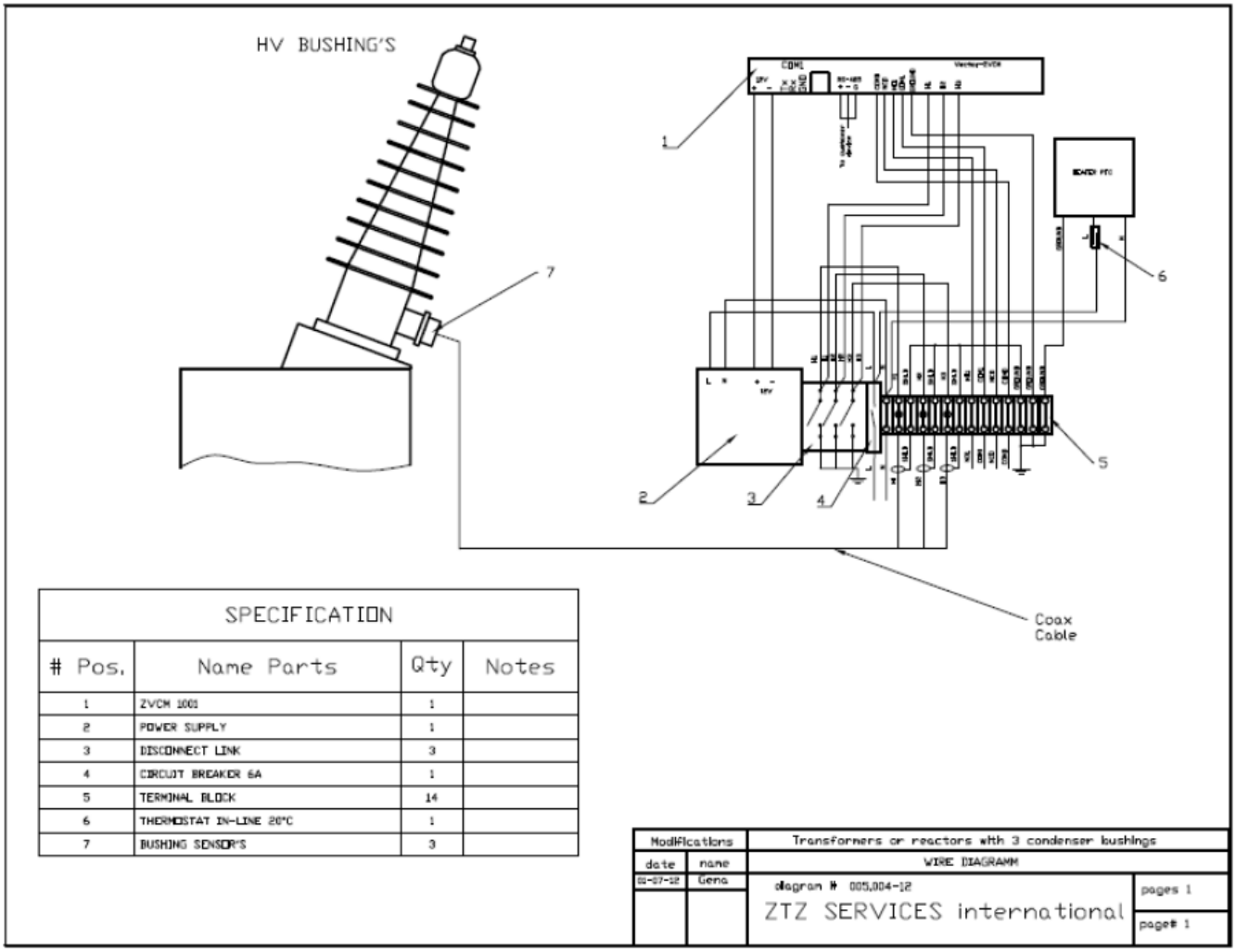


View of standard ZVCM Bushing Monitor on back panel with power supply, shorting switches, circuit breaker, ground bar, and bushing sensor connection points.

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Pictorial diagrams are shown for different transformer configurations

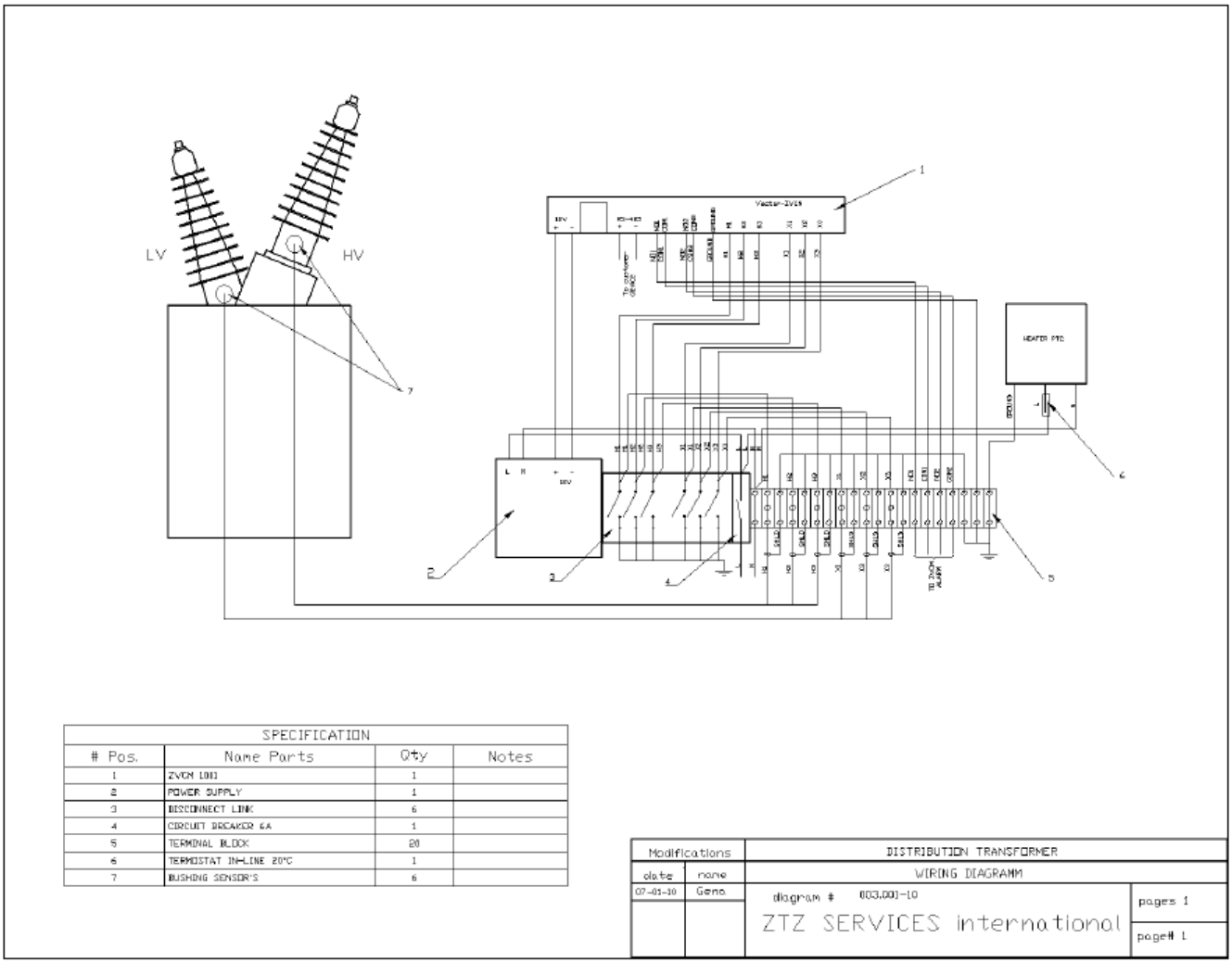
2.1 Transformers or Reactors with Three Condenser Bushings



The coax cables from each bushing sensor are marshaled into a single conduit to the enclosure. It is standard practice to carefully measure each coax and mark it so that when they are dressed and terminated at the terminal strip, all coax runs are the same length. The excess coax from the nearer bushings is neatly coiled and placed at the bottom of the enclosure.

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2.2 Distribution Transformer

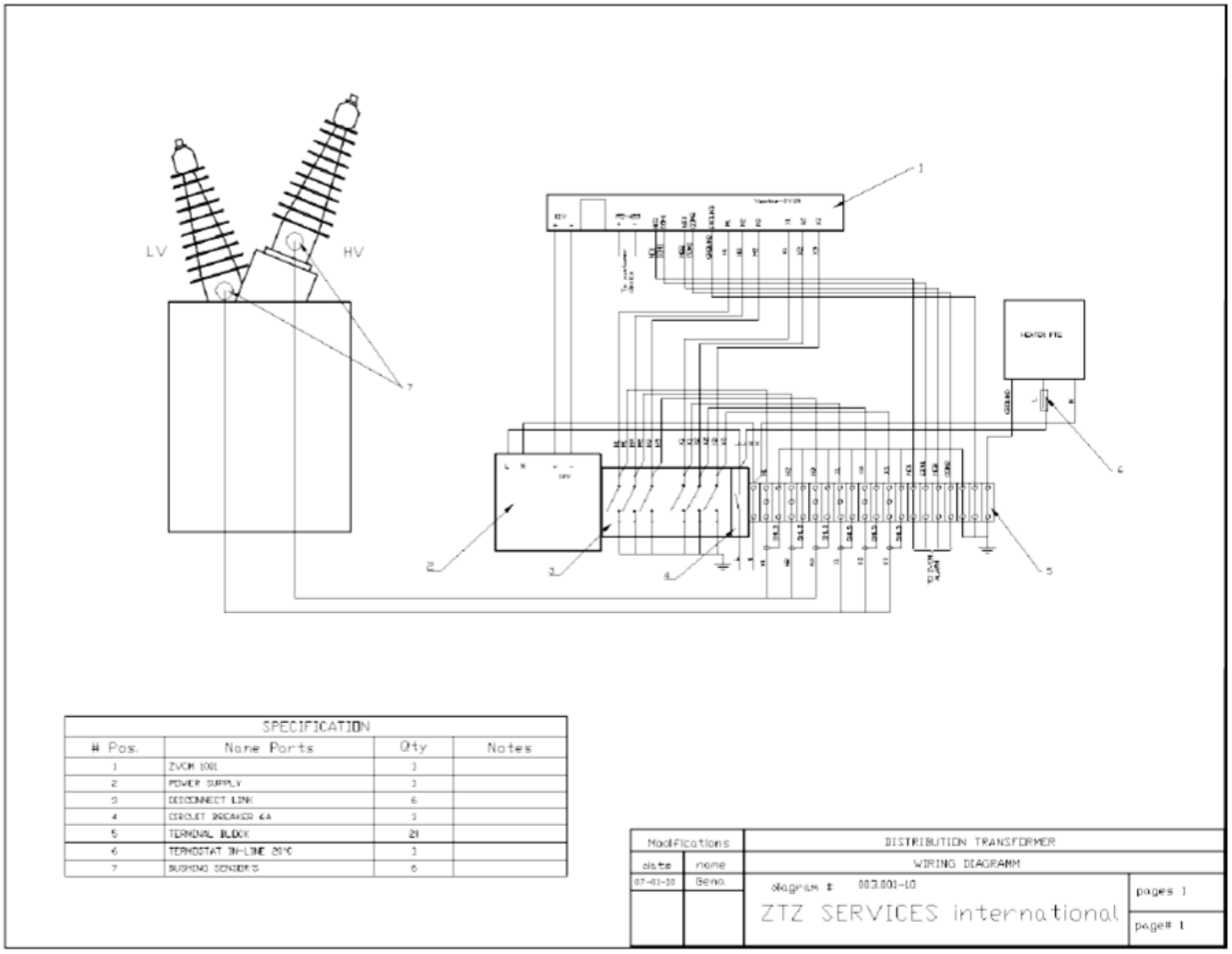


SPECIFICATION			
# Pos.	Name Parts	Qty	Notes
1	ZVCM 1001	1	
2	POWER SUPPLY	1	
3	DISCONNECT LINK	6	
4	CIRCUIT BREAKER 6A	1	
5	TERMINAL BLOCK	20	
6	TERMOSTAT IN-LINE 20°C	1	
7	BUSHING SENSOR'S	6	

Modifications		DISTRIBUTION TRANSFORMER	
date	name	WIRING DIAGRAMM	
07-01-10	Gene	diagram # 003.001-10	pages 1
		ZTZ SERVICES International	page# 1

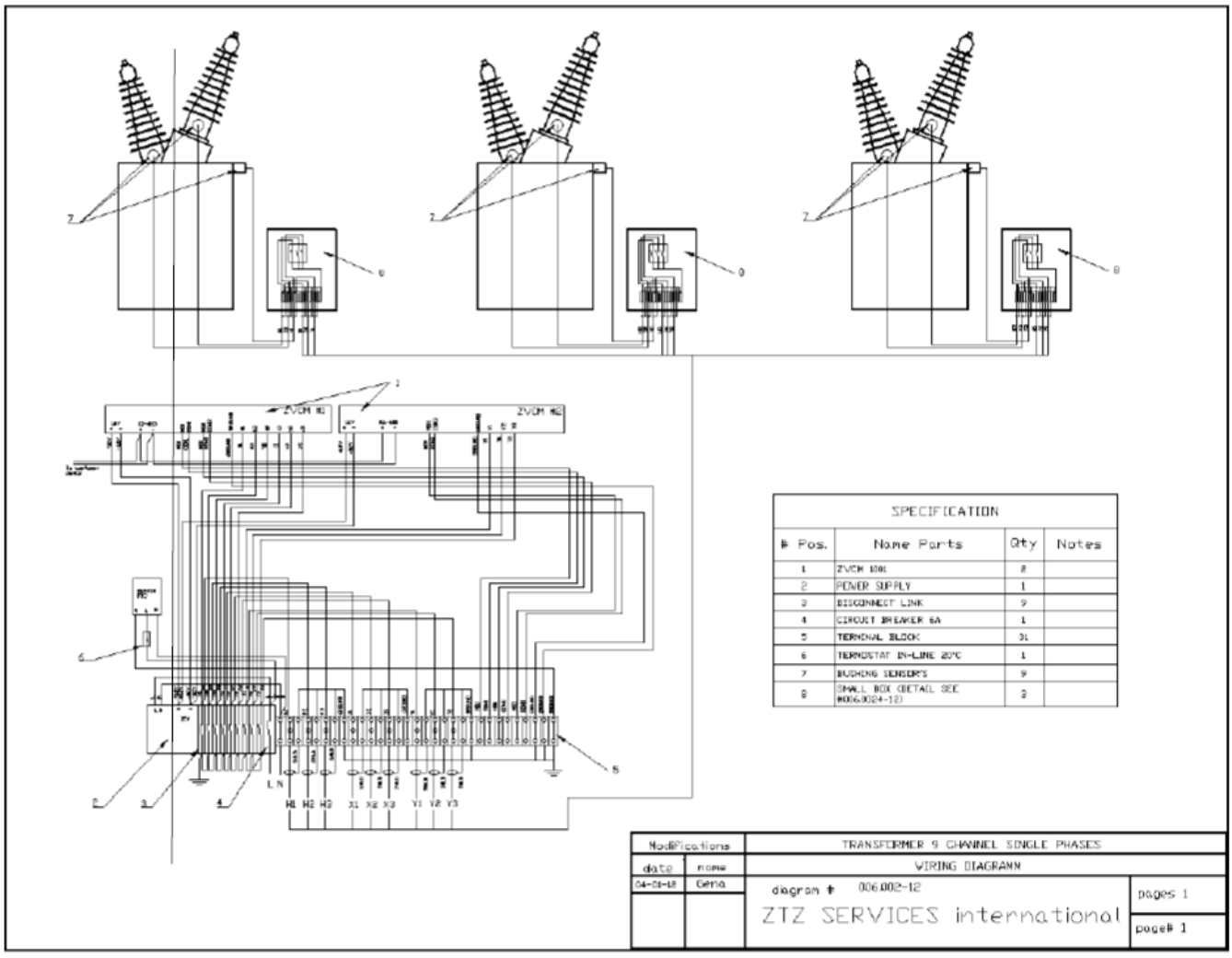
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2.3 Nine Bushing Transformer



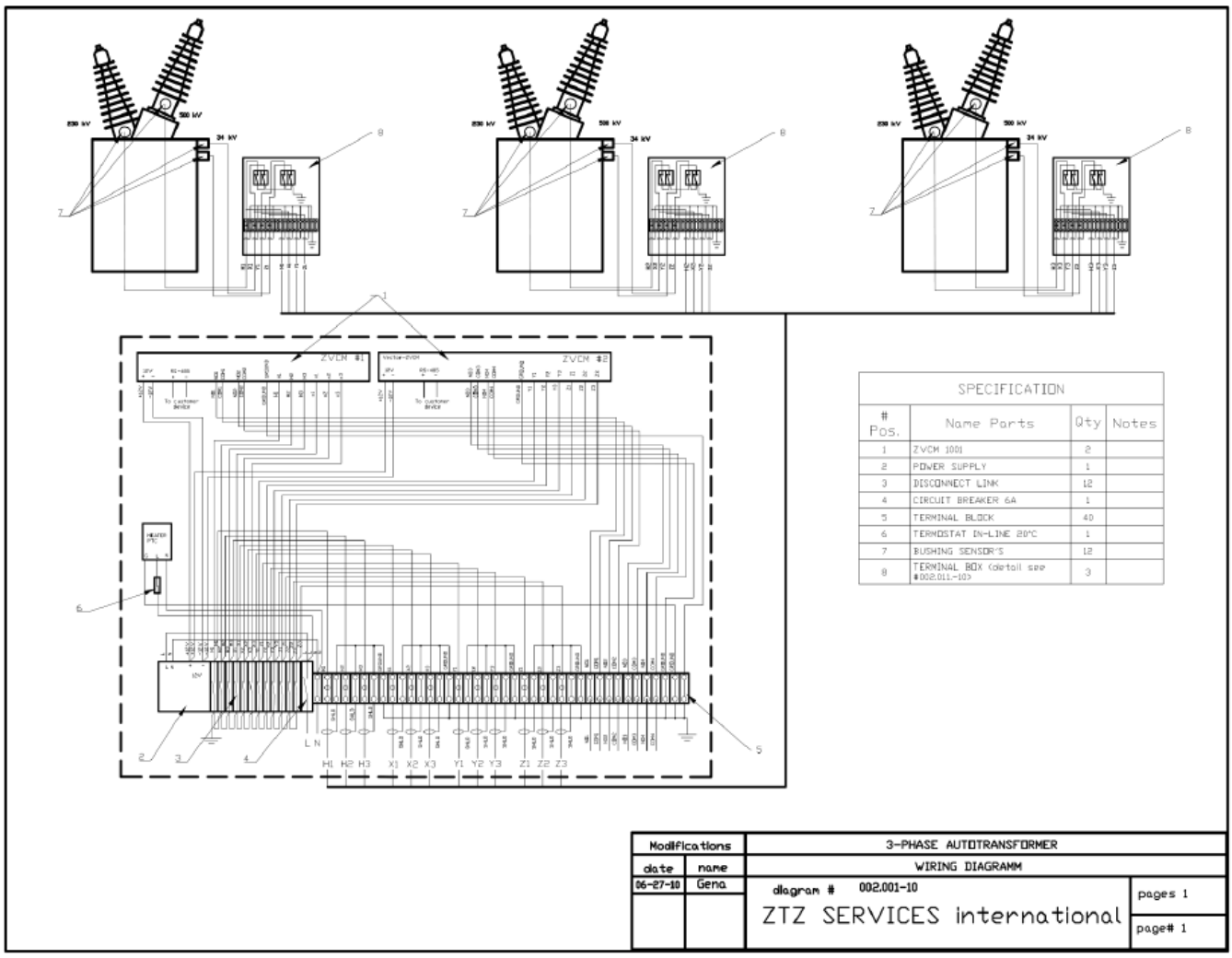
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2.4 Three Single Phase Transformers- Nine Bushings



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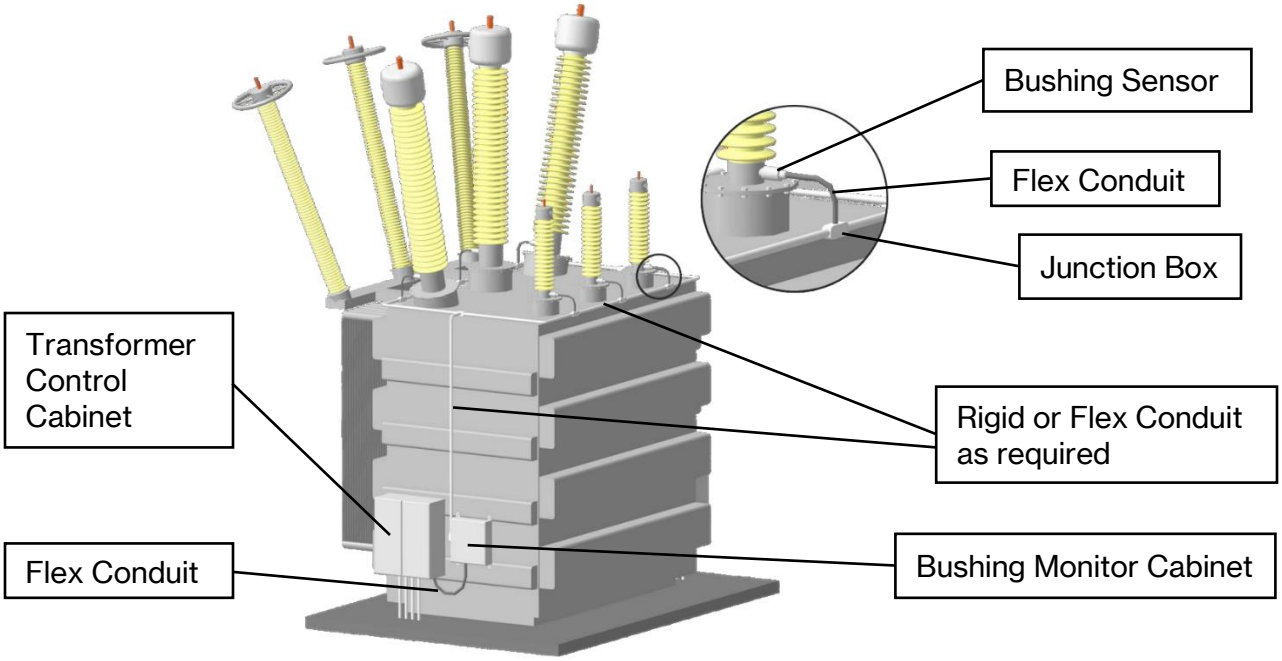
2.5 Three Single Phase Transformers- Twelve Bushings



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3.0 INSTALLATION AND CONNECTIONS

This section gives information on ZVCM Enclosure dimensions and mounting, hookup of power, and installing the sensors to the bushings on the transformer.





Wiring looms are prepared on the ground from bushing spacing measurements. One loom for the high side and one for the low side. Coax cable is measured so that each run is the same length from the sensor to the monitor terminal. Excess cable is placed at the bottom of the cabinet.

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An efficient process is to then hoist the assembly to the top of the transformer with a rope. The sensors are temporarily secured to the conduit and wrapped in their protective covering during this process. The conduits are then fastened to the transformer steel using suitable clamps.





With the conduits placed and secured, the sensors are ready to be installed on the bushings. The test tap cover is removed, threads inspected and cleaned, then petroleum jelly is applied to the threads and O-ring of the sensor.



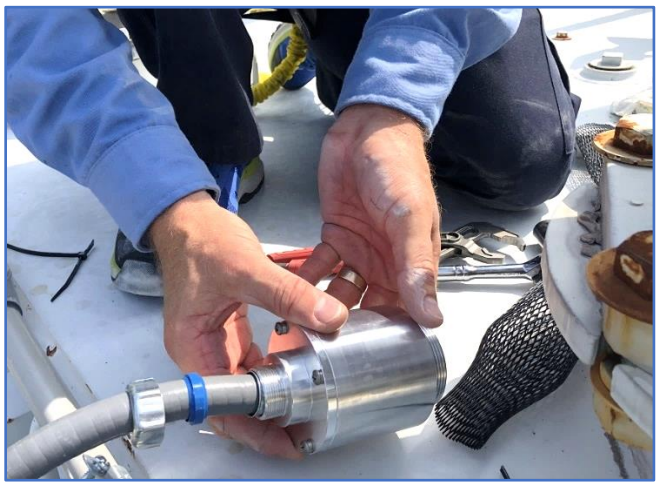




The typical bushing sensor engages about five threads. Before the sensor is installed, pre-charge the cable by rotating it counter-clockwise- five turns. Remove the protective cover. Carefully and slowly engage the sensor while turning it to be sure the threads are mating correctly and not cross-threading.

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When the sensor is snug, use a Channellock plier or similar tool to tighten to 10 foot-pounds. Assemble the flex conduit fittings and tighten them. Wipe fittings and sensors clean and do a final inspection before leaving the top of the transformer.



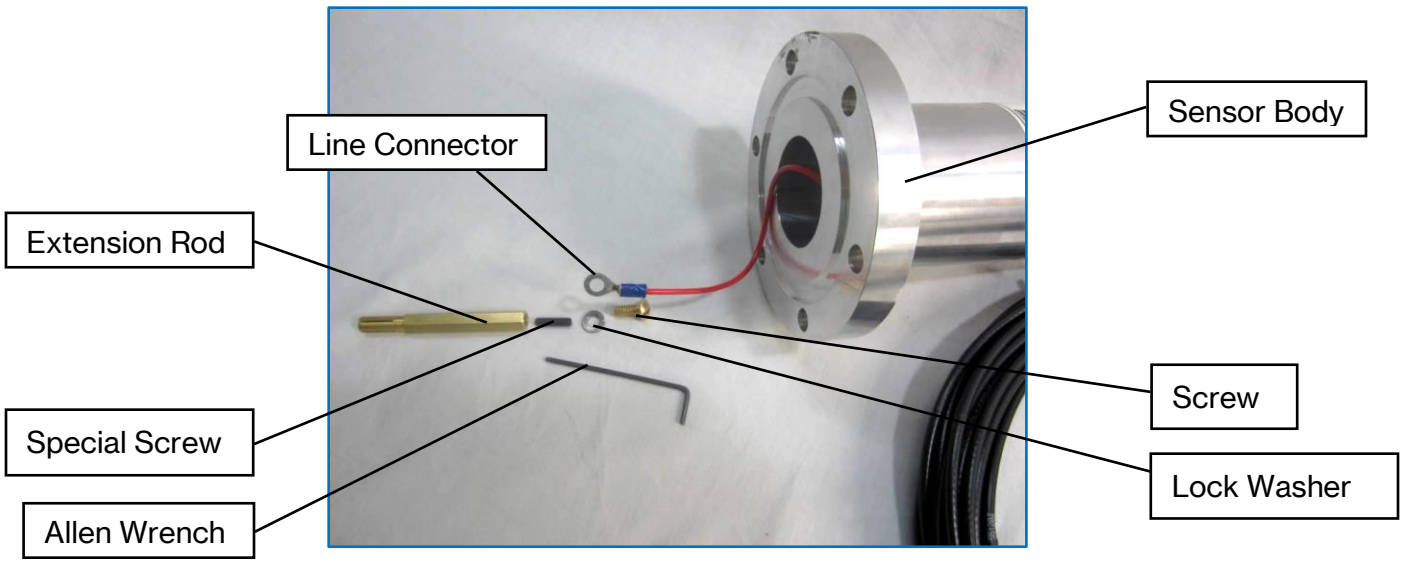



The high-side and low-side conduit runs are connected at a 3-way junction box and a single conduit is installed down the side of the transformer. It will have six coax cables in it. This conduit is run into the bottom of the monitor enclosure with a suitable length of flex conduit for the last few feet with enough extra to form a drip loop.

3.1 Flange Sensors

Flange sensors are an important specialty of ZTZ. This section details the process of sensor installation onto flange sensors.

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3.2 Checking the Flange Sensor

Using a multimeter, measure the resistance between the cable sheath and the body of the flange sensor and between the central wire of the coax cable and the sheath. Measure the resistance between central wire of the coax cable and the sheath or body of the sensor. It should be approximately 1000 Ohms ±15% . The meter shown below is reading kΩ.





3.3 Removing the Cover from the Flange

Using a socket or wrench, remove the bolts around the outer edge of the flange. Remove the cover and inspect the inner tap connection for any problems. Wipe it clean.

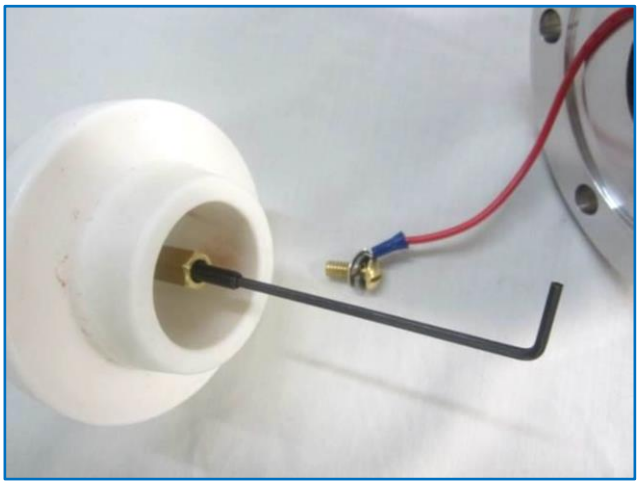
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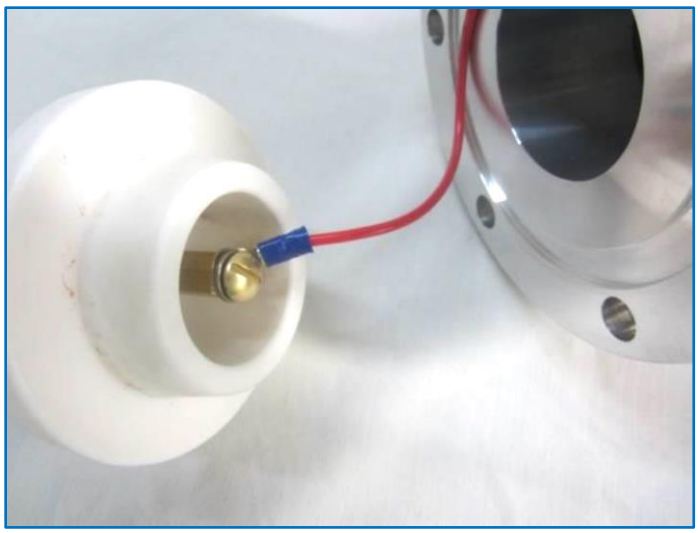
Install Extension Rod by inserting it into the center of the tap. Then insert the special screw, tightening it with the long end of the Allen wrench.

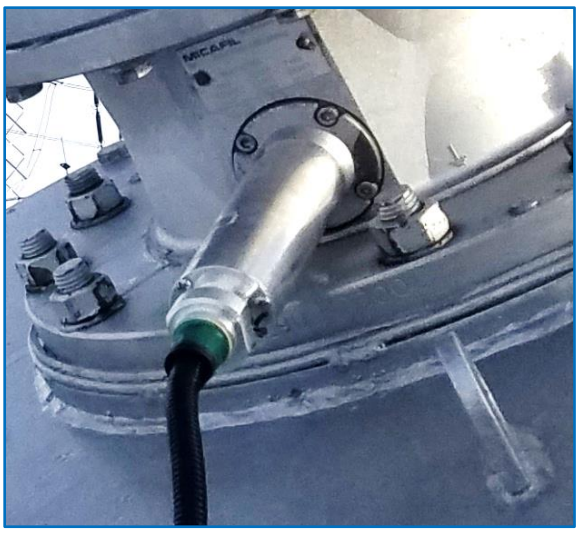




After the extension rod is installed, prepare to connect the red wire to it by first making sure the sealing O-ring is in place on the sensor before you connect the wire.

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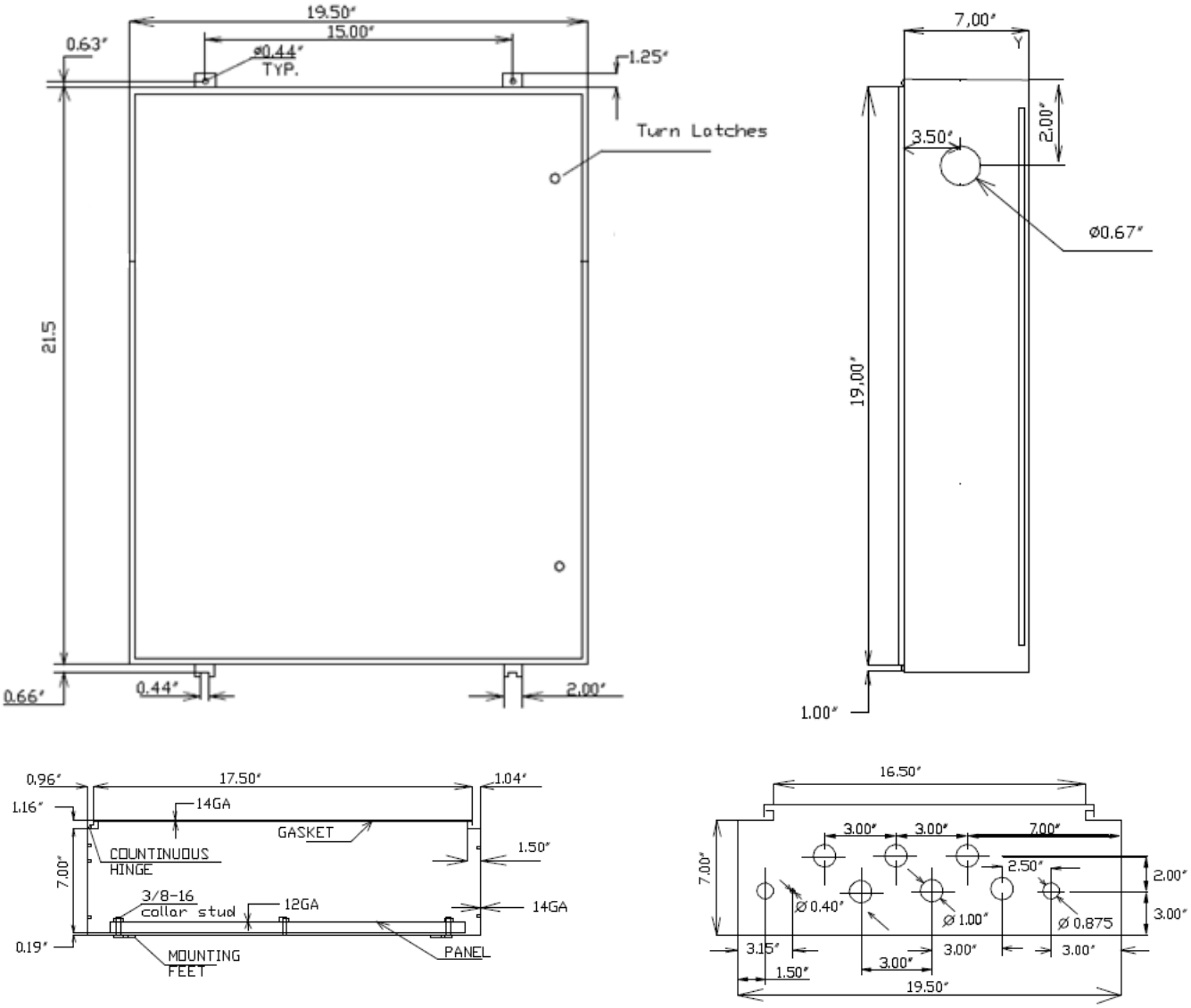
Install the flange sensor onto the bushing body. Use utility-recommended practice and torque for tightening onto circular O-rings. After installing the flange sensor to the bushing tap, measure the resistance between central wire of the coax cable and the sheath or body of the sensor.

Route the coax cable through the flexible conduit and onward to the ZVCM enclosure. Tighten the flex conduit connector as shown earlier in this section.

4.0 MOUNTING THE ZVCM ENCLOSURE

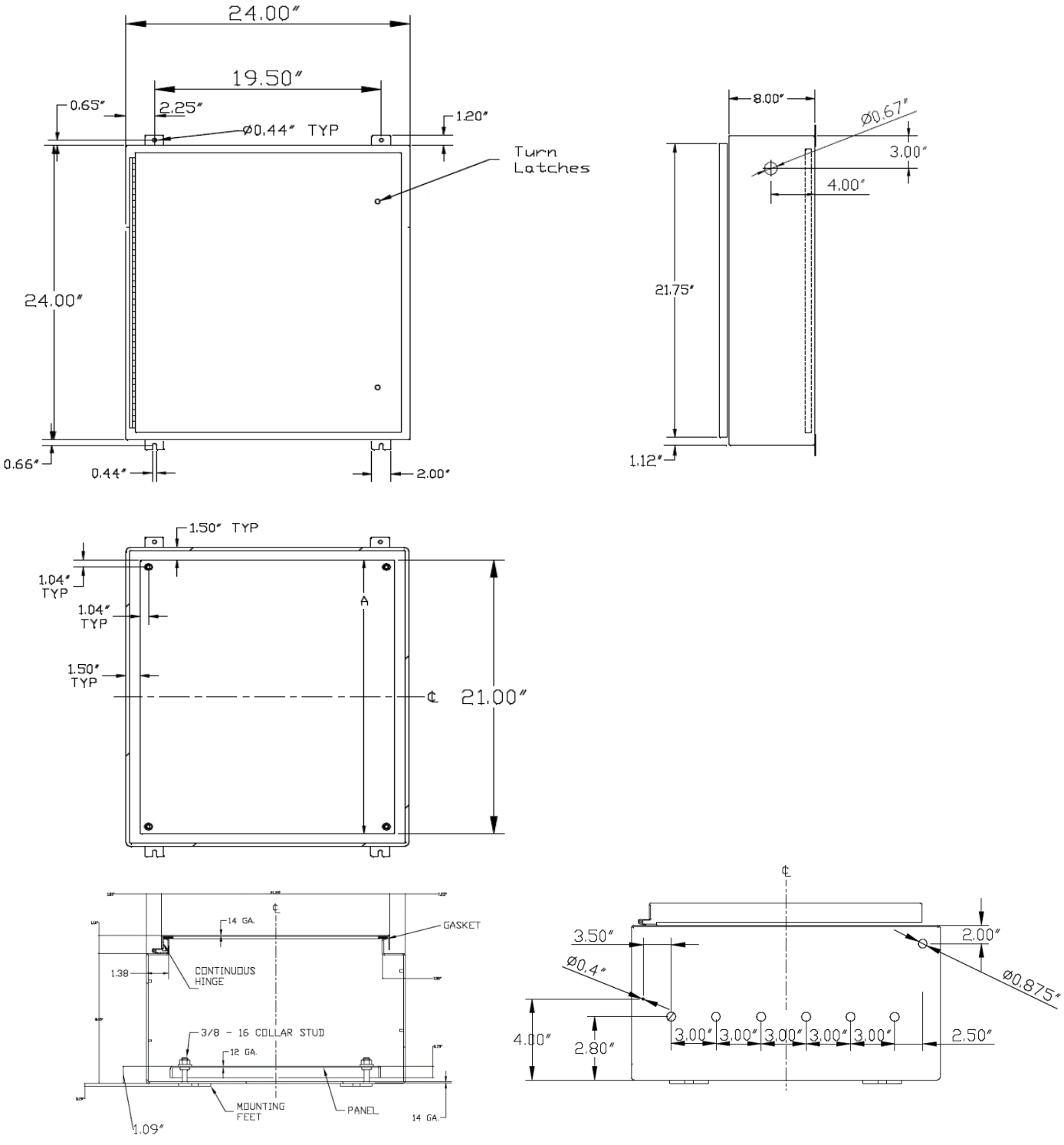
The standard enclosure is 14 gauge 304 stainless steel and is rated for outdoor installation. The interior mounting panel is 16 gauge 304 stainless steel. It is installed on a stand-alone rack or on the transformer tank. If the ZVCM enclosure is mounted on the transformer tank, vibration buffers need to be installed.

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Three or Six Channel ZVCM Enclosure Dimensions.

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Nine or Twelve Channel ZVCM Enclosure Dimensions

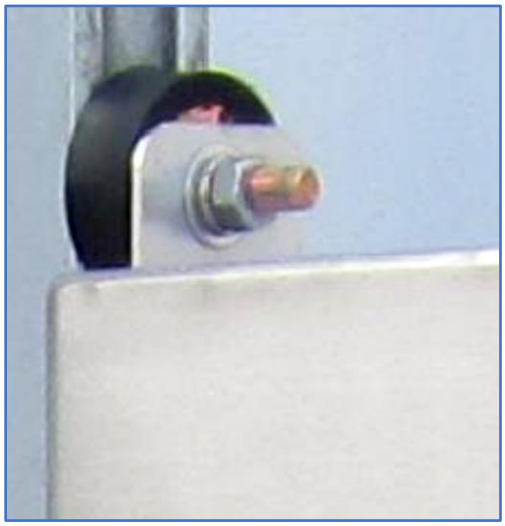
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Enclosures mounted near transformer control cabinet using ZTZ-supplied galvanized stands; fastened to concrete using shields and bolts.





If ZVCM enclosure is mounted to the transformer steel, then vibration isolators are needed.



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5.0 Bushing Sensor Connections to the ZVCM Inputs

Before terminating the coax cable to the terminal row inside the ZVCM Enclosure, it is recommended that ferrules be installed on the central wire of the coax cable and to the sheath.





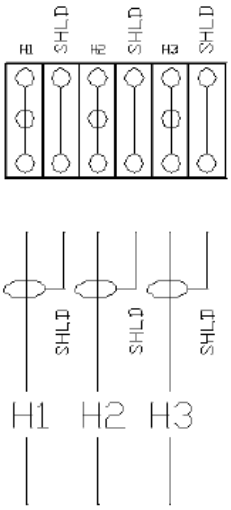
Multimeter shown in kΩ.

Prior to terminating the coax cable to terminal row inside the ZVCM enclosure, measure the resistance (capacitor) between the central wire of the coax cable and the sheath and measure the capacitance between central wire of the coax cable and the sheath or body of the sensor. It should be approximately 1000 Ω ±15% for VBS type sensors and 1.080 uF±15% for VBC type sensors.

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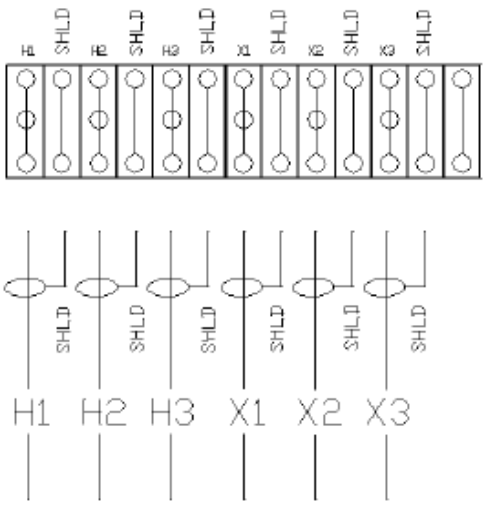
5.1 Termination of Coax Cable at the ZVCM Monitor Inputs

Three Channel





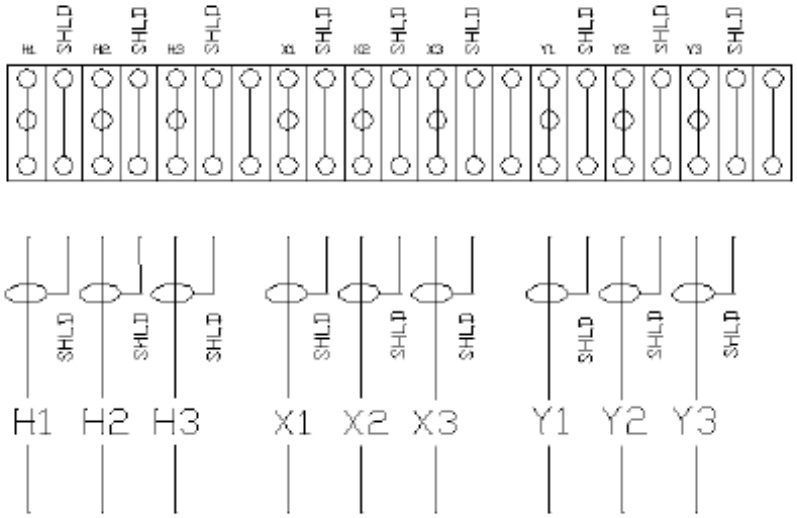
Six Channel

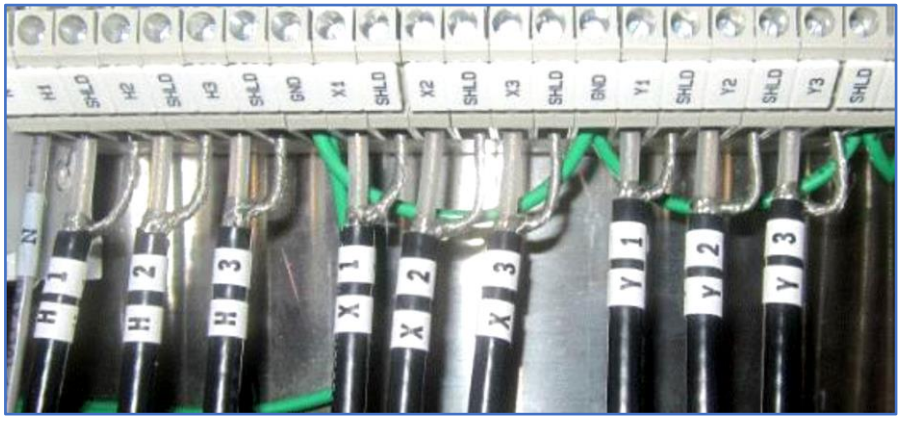




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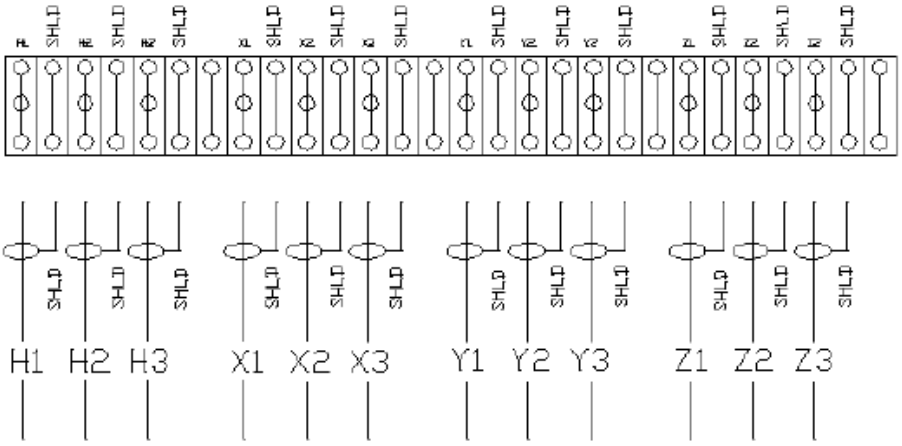
Nine Channel





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Twelve Channel

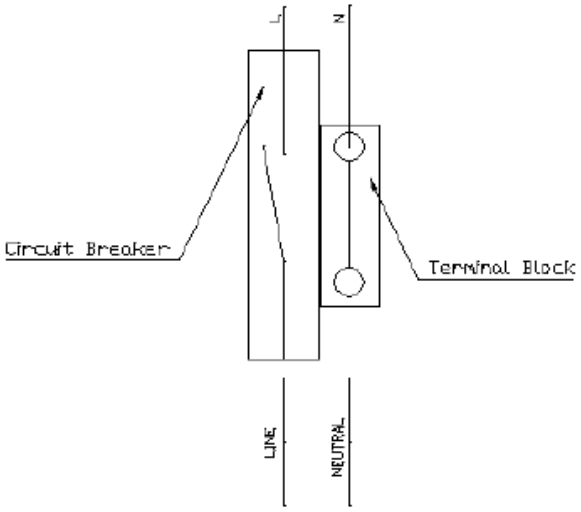


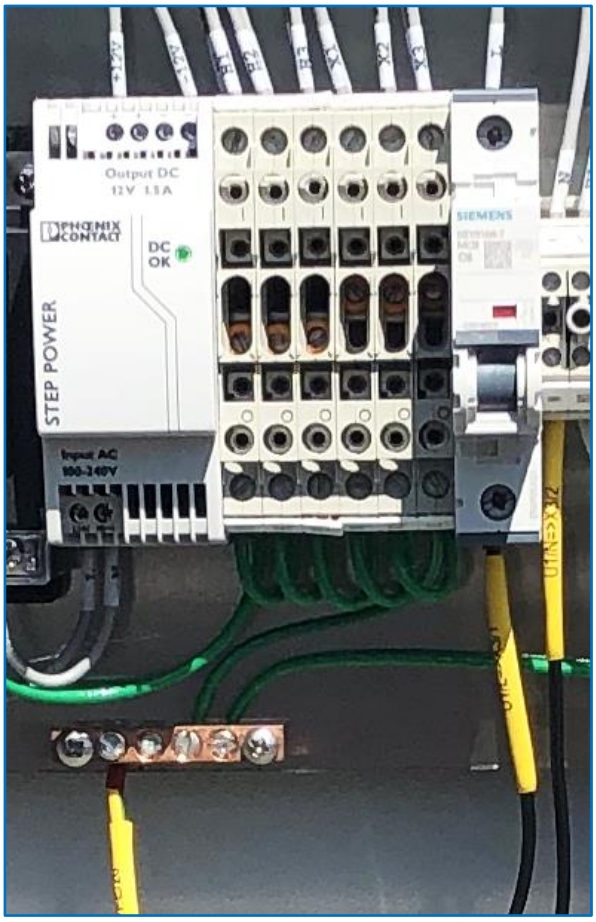


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5.2 Input Power Connection

The ZVCM can be powered with AC voltage from 120~240 VAC. The power input line is connected to the circuit breaker, neutral to terminal block, ground to the ground bar as shown below, wires with yellow markers.





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5.3 Alarm Connections









One ZVCM Bushing Monitoring System can monitor one or two sets of three bushings and has alarms for HV and LV bushings. For nine or twelve bushings, two ZVCM systems are used.

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